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BUREAU OF PLANT INDUSTRY—Circular No. 77.

B. T. GALLOWAY, Chief of Bureau.

A STUDY OF THE IMPROVEMENT OF CITRUS FRUITS THROUGH BUD SELECTION.

BY

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A STUDY OF THE IMPROVEMENT OF CITRUS FRUITS THROUGH BUD SELECTION.[1]

INTRODUCTION.

In April, 1909, under instructions of the Chief of the Bureau of Plant Industry, the writer visited a large number of orange, lemon, and pomelo groves in southern California, accompanied by Mr. G. Harold Powell, at that time in charge of fruit transportation and storage investigations of the Bureau.

In all of the groves it was easily apparent that great differences existed in the quantity and size of the fruit, in the proportion of irregular and abnormal fruits, and in the habit of growth and leaf characters of the trees among neighboring trees of the same variety, in the same grove, and under uniform conditions.

One of the largest and most successful citrus growers in California, at Riverside, when questioned as to the cause of these striking differences, suggested that it might be due to variation in the buds from which the trees were propagated. He stated further that he believed that 60 per cent of the trees in his orange groves produced his crops and that the remaining 40 per cent were light producers or barren and practically worthless.

Little or no selection of buds from select trees has thus far been practiced in the propagation of citrus trees. In most instances the propagator secures buds from successful growers of a given variety, taking the buds without regard to the past or present crops of fruit borne by individual trees. In some cases the buds for propagation are cut from nursery stock, where no selection of buds based on crop performance is possible. Where selection of buds has been practiced, almost invariably the propagator has selected the largest and most vigorous trees without regard to the crop of fruit borne by them.

Owing to the fact that the introduction into California of the commercially successful varieties of citrus fruits is of comparatively

[1] This circular has been prepared with a view to supplying information regarding the methods of work used in investigating the variation in the yield of citrus fruits in California. It is not intended here to present definite results of this work. Many investigators and fruit growers in different parts of the United States are interested in this type of investigation, and it is believed that a description of the Bureau work at this time will aid materially in assisting those who desire to pursue similar lines.—Wm. A. Taylor, *Acting Chief of Bureau.*

recent date, the demand for trees of these varieties has been greater than could be supplied, and it has not been practicable to wait until performance records of individual trees could be secured. It was only possible to propagate stock true to variety, which under the existing conditions thus far has been the one consideration of vital importance to the growers of citrus fruits. In fact, it was usually considered that any bud from a Washington Navel tree, for example, would produce a Washington Navel tree like its parent, and the possibilities of bud variation were not seriously considered.

The owner of a pomelo grove in San Diego County observed that a few of the trees purchased a number of years ago, after reaching bearing age, produced large crops of fine seedless fruits, while others near by were not only light bearers but produced a large proportion of fruits containing many seeds and of undesirable size and otherwise unprofitable. In planning for the planting of a new and larger grove this owner selected the two trees in the original plantation which he had observed were consistently larger yielders of desirable fruits. He cut all of the buds for propagating the trees for his new grove from these two trees. The new grove is now in full bearing and produces uniformly a large yield of seedless fruits of desirable size and shape. This grove is a striking example of the benefits to be gained from bud selection, as shown by comparison with the older groves where bud selection was not practiced.

These observations were made preliminary to the undertaking of an investigation by the Bureau of Plant Industry of the effect of bud selection in response to the urgent desire of the citrus growers of California. After going over the ground and noting many examples of individual variation it was decided to undertake a systematic study of the variation of citrus trees in southern California, and the writer was directed to begin work. Several months were spent in a study of groves in different sections, so that suitable locations could be selected where the conditions were such that the data obtained would be reliable and of permanent value. As a result of the friendly and generous spirit of cooperation evinced by the growers it was possible, in every case where it was thought best to undertake this work, to make satisfactory arrangements to carry on the investigations without expense to the Bureau for as long a period as might prove necessary. Owing to various causes of variation in the yield of trees, such as seasonal changes, it is planned to continue the study of a given tree for at least five years before conclusions are drawn as to its productive behavior or its relative value as a source of buds for propagation.

The work has been carried through one season, and although the data obtained are far too meager to be conclusive in any way they are very suggestive as to the practical possibilities and commercial

importance of this line of work. In response to the general desire of citrus growers and others for information regarding the object and plan of the work, this brief preliminary report is presented. The data are presented only in an illustrative way, so that an intelligent idea may be gained of the methods used. While these investigations must, as a matter of necessity, cover a long period of time, it is not unreasonable to expect that the data obtained from the second and successive years will yield interesting and valuable results, and reports giving the data secured and the progress of the work in all its aspects will be issued.

The writer hopes that this circular will lead more citrus growers to interest themselves in the investigations to the extent of securing data on the yield of individual trees in their groves where the conditions of soil and other factors are uniform and comparative. All the equipment that is needed is a fairly accurate scale that can be taken into the orchard and moved readily from tree to tree, a set of rings corresponding to the sizes of the fruit studied for aid in dividing the product of each tree into commercial sizes, and a notebook arranged for keeping the data in a systematic manner. All of the fruit of an orange tree may be picked at one time, and the sizing, grading, and note taking should be done, as soon as the fruit is picked, by the grower or some one who can do this work consistently and continuously for a period of several years. The method used by the writer of securing data of individual trees will be outlined in the following pages as a suggestion for a practicable method of note keeping. If this method is not suitable for any reason, it can probably be modified or changed so as to permit of satisfactory practical use by the grower.

OBJECT OF THE INVESTIGATIONS.

The first object of these investigations is to determine definitely the performance of individual citrus trees of the same variety, in the same grove, and under uniform conditions for a period of at least five years.

If, as the data obtained during the past season show, it is found that there is consistently a great variation in the quantity, quality, and value of the fruit borne by different trees of the same variety under like conditions, it will be determined whether these crop characteristics are transmissible and whether the progeny of these trees behave like their parents.

If it is found that one tree of a given variety yields consistently larger crops of more valuable fruit than other trees of the same variety under comparative conditions and that trees propagated from this tree inherit this tendency, it follows that the propagation of an improved type of the variety from the desirable tree should be both possible and practicable.

The influence of the seedling stock on the development of the buds from select parent trees will be investigated, and the importance of the selection of seedlings for budding purposes will be studied. There is no question as to the fact that citrus seedlings vary greatly in vigor and habit of growth and in other characteristics, but the effect of these variations on the development of the scions is a matter as yet undetermined, although they are probably of importance so far as the development and behavior of the tree is concerned.

At the time of picking careful photographic and other notes are made of each tree, its fruit, and other characteristics, so that, if results warrant, score cards and standards of selection may be devised intelligently for the different varieties of citrus fruits to aid in the study and selection of breeding stock.

The demonstration of methods for the elimination of unproductive or worthless trees in established citrus groves by rebudding or replanting and the establishment of reliable sources of uniform stock of citrus fruits for new plantings are the ultimate aim and object of this work. The data secured in the course of this work will constitute "pedigree records," based on the performance of the trees studied. The value of such pedigrees will depend on the conditions under which the data are obtained and the accuracy and care used in picking, sizing, sorting, and weighing the fruit.

VARIETIES OF CITRUS FRUITS SELECTED FOR PERFORMANCE RECORDS.

The Washington Navel orange was the variety selected with which to start the work. The commercial success of this variety is fully established in California. Its introduction into southern California is of comparatively recent date and all of the details relative to its introduction and distribution are fully known. There is probably less variation in the groves of this variety than in groves of other varieties now growing in southern California, so that if bud variation is found to be important in the case of the Washington Navel orange it is probably of more importance to the other varieties. As the two parent trees from which all the trees of the Washington Navel orange in southern California have descended are now growing at Riverside, Cal., there is an unparalleled opportunity to study the influences of change of environment and bud variation, as shown by a comparison of the parents with their descendants, many groves of which are growing under widely differing conditions of soil, altitude, climate, and culture. The history of practically every Washington Navel tree in California can easily and definitely be traced to the two original trees, so that clear-cut conclusions can be drawn as to the influence of different factors on the development of the variety since its introduction. The fine quality of the Washington Navel orange and its high value

when grown under favorable conditions were other factors that entered into the decision regarding the selection of this variety for the work. As the work progresses the trees which consistently yield favorable data should become the source of improved stock for planting, thus greatly enhancing their value for experimental demonstration purposes and making possible the early practical utilization of the information obtained.

In addition to the Washington Navel orange, work with the Marsh pomelo was begun during the season of 1910. The picking of the fruit from the selected Washington Navel orange trees began January 1, 1910, and continued until April 15. The pomelos were picked from April 15 to June 15. The different picking periods of the two fruits enabled work upon both to be carried on without interference. The Marsh pomelo was selected for the reason that it is the most important commercial variety of pomelo grown in California, on account of the importance and desirability of securing uniform types of this fruit similar to the splendid individual trees both as regards quantity and quality of fruit found in some of the established groves of the variety, and because it offered the most promising field for the production of a perfectly seedless and valuable pomelo for southern California conditions.

The extension of this work to other classes of citrus fruits is highly desirable. In southern California numerous requests have been made urging that lemons be included in the work, in order that reliable select stock may be obtained for extensive new plantings of this fruit. In some cases prospective lemon planters are carrying on the work for themselves, with the writer's advice and direction, with every prospect of success in the securing of reliable data for their own information and use.

This type of investigation should ultimately be extended to all valuable varieties of citrus or other fruits. All varieties do not behave alike and may differ in their hereditary tendencies, so that in order to draw conclusions regarding the behavior of any variety it will be necessary first to demonstrate the facts by actual tests.

LOCATION OF PERFORMANCE-RECORD PLATS.

The Washington Navel orange improvement work is done on the Eureka and Vivienda ranches belonging to the National Orange Co., near Riverside, Cal. The Marsh pomelo work is conducted on the Dixon ranch, operated by Mr. L. V. W. Brown, near Riverside, and on the Mutual ranch of the National Orange Co., near Corona, Cal.

The term "performance-record plat" is here used to designate the collection of trees selected for obtaining comparative data as to variation in the performance of individual trees. The Washington Navel orange plats will be described in order to illustrate the methods by which these data are obtained.

The Washington Navel orange performance-record plats are located on the Eureka ranch of about 175 acres belonging to the National Orange Co. The ranch lies on an elevated mesa surrounded on the north, east, and south sides by the Box Spring Mountains, and sloping gently westward to the Santa Ana River. The elevation is such that cold weather has never injured either the trees or the fruit, and a deep arroyo running between the ranch and the mountains and on the west side perfectly isolates and protects the groves. The ranch itself is divided by an arroyo running approximately north and south, so that it really consists of east and west sections, or groves, of about the same area. The two sections are planted to the same stock of Washington Navel trees, now 12 years old and in perfect health and bearing condition.

After careful consideration it was decided to locate two performance-record plats, one in each section, of 50 trees each, in order to secure duplicate data and more fully check the results of the investigations. Both plats were chosen to eliminate all possible factors other than heredity. They are located about in the center of each grove, and where the conditions of soil, planting, culture, lay of the land, and health of the trees are as uniform and comparable as it is possible to find in this region. The land was not cultivated before planting the grove and, since planting, all parts of the grove have been treated the same in every respect. The grove has produced, since coming into bearing, regular crops of fruit the high quality of which has made a national reputation, and not a single diseased or unhealthy tree has been found in the grove. The trees are free from insect pests and fungous diseases.

The soil is a granite loam of an unknown depth, typical of the soil producing the finest navel oranges. In the performance-record plats the trees are all in a normal, healthy condition and are set at regular distances, and in no case are there any vacant spaces, roadways, replants, or other factors to interfere with their similarity. The record plats are treated exactly like the rest of the grove, the only difference in any respect being that the fruit is picked under the immediate supervision of the writer instead of by the regular picking gang.

The plats consist of five rows of trees side by side 10 trees long, making a total of 50 trees for each plat. Particular care was taken to secure in each plat an average lot of trees representing the average of each grove. No dwarfed or markedly inferior trees or any trees producing abnormal fruit were included.

SELECTION OF INDIVIDUAL TREES.

In addition to the performance-record plats on the Eureka ranch, 21 individual trees, representing different types of the Washington

Navel orange so far as could be determined, were selected and picked in various parts of the groves for illustrative purposes.

On the Vivienda ranch, lying west and below the Eureka ranch, 50 individual trees were selected on the basis of high yield. These 50 trees are all of the type of the Washington Navel orange and are located under conditions similar to those in the remainder of the grove. A record of the yield of each size and grade of fruit from both the Eureka and Vivienda ranches is kept by the National Orange Co., so that the yield of the select trees can be compared to the average yield per tree of the groves.

TREE MARKERS AND NUMBERS.

Strips of heavy white cotton cloth about 4 feet long and 2 inches wide were tied in conspicuous places at four regular intervals around the tree and at a height of 6 or 7 feet above the ground. These streamers can be plainly seen from any side of the tree and were placed to prevent the picking of the trees by the regular picking gang.

In the case of the Washington Navel orange every select tree was given a number, from one consecutively to the total number of trees studied. This number was stamped with a metallic die in a strip of copper 1 by 4 inches in size, so as to be ineffaceable. A heavy copper wire 12 inches long was soldered to this tag, and the tag corresponding to the number of the tree was attached to the tree by twisting the wire loosely around one of the main branches near the tree trunk.

In order to assist in finding the tree numbers readily and conveniently, the number was also painted with white paint on the tree trunk in large numerals and always on the same side of the tree.

A diagram was made of each grove, showing the location of each tree marked, in order to assist in finding individual select trees scattered over the groves. It is evident that great care must be exercised in preserving the tree numbers in order to avoid the loss and confusion of the data through a period of years.

PERFORMANCE RECORDS.

By "performance records" is meant the data obtained from the individual trees as to the yield and quality of fruit each year. A consecutive series of these records constitutes a performance record of the trees from which the data are obtained. "Quality" in this work means the proportion of the different sizes and grades of fruit, thus determining the commercial value of the fruit from each tree. No definite means of recording the flavor, sweetness, acidity, quantity of juice, rind, etc., has been evolved as yet, although a serious attempt is being made to secure these additional data for future records. These performance-record data are obtained in the grove and one tree is finished before any other is picked. The fruit from each is picked,

graded, sized, weighed, and counted, and the notes are taken in order to avoid any possible confusion, mistake, or loss of fruit. The fruit is then taken to the packing house and packed with the other fruit from the grove. To anyone familiar with the difficulty in securing

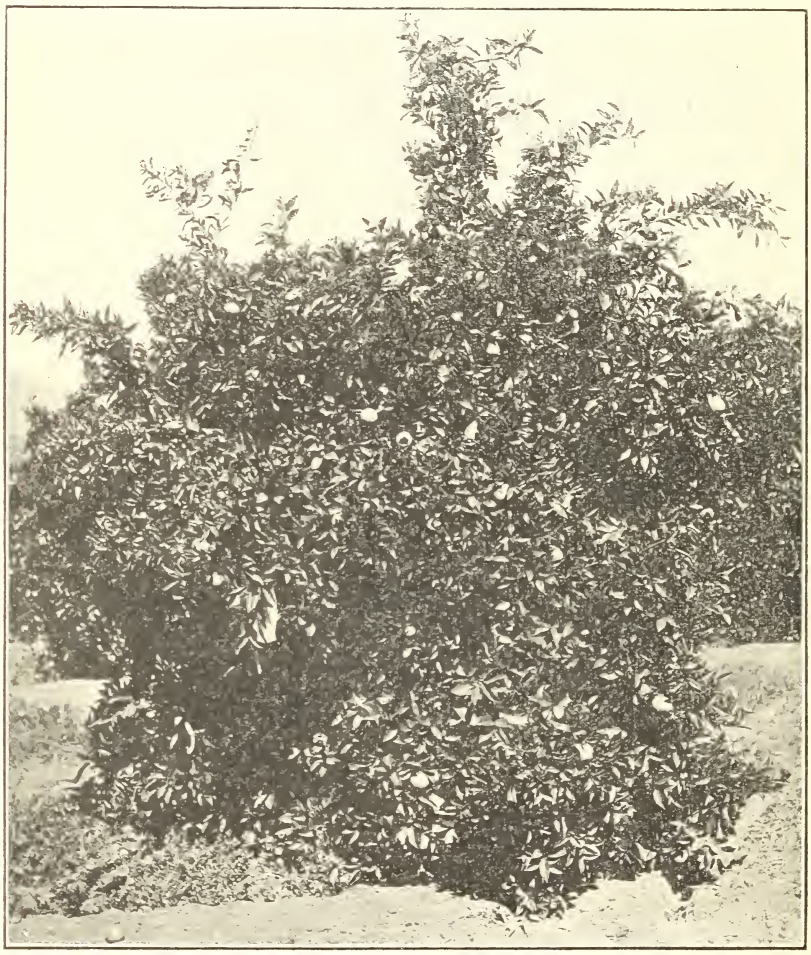

FIG. 1.—Ideal type of tree of the Washington Navel orange, the most productive tree in 1910. The crop is practically all borne on inside branches.

reliable data in corn, tobacco, or other breeding work it is apparent that this work is simply done and is more valuable as a basis for selection than in the case of data secured from cross-fertilized plants or annual crops of any kind.

PHOTOGRAPHS.

Two photographs are taken of each tree—one before and one after picking. The photograph before picking gives an idea of the

distribution of the fruit on the tree. After picking, the boxes of fruit are assembled side by side at the foot of the tree in one continuous row, slightly inclined to show the fruit in the boxes, so that the photograph gives a complete illustration of the total quantity of fruit from each tree. These photographs preserve better than language can express the habits of growth and other characteristics of the individual trees. Figures 1 to 4 give an idea of some of the striking differences in the character and

FIG. 2.—Typical heavy-producing Washington Navel orange tree, showing a large proportion of outside fruit.

habits of growth of the different trees, as shown by the photographic records. No notes or descriptions would serve so adequately to preserve these data or to present them in such comparable form.

The photographs are attached to the sheet bearing the data secured from the study of the fruit and are invaluable aids in interpreting the results.

PICKING.

The picking of each tree is done by an expert regular picker furnished by the grower, under the immediate supervision of the writer. Every possible care is used to prevent injury to the fruits, both in picking and in all other operations. The fruit is picked in the usual manner and placed in picking boxes. All of the fruit is picked, the boxes are assembled, and the photograph of each tree is made before

FIG. 3.—Typical "barren" type of Washington Navel orange tree.

the sorting or any other operation is begun. No fruit is picked and allowed to stand overnight before the several operations are completed.

GRADING AND SIZING.

The fruit of each Washington Navel tree is sorted into three grades by the writer: (1) Orchard grade, representing all of the perfect fruit, without injury or blemish; (2) standard grade, or fruits of irregular shape, blemish, or discoloration, but still suitable for shipment as an inferior grade; and (3) culls, or fruits so badly malformed or with such marked blemishes as to render them unfit for shipment or sale.

The orchard and standard grades are sized with a small automatic sizer into 11 different commercial sizes, viz., 80, 96, 112, 126, 150, 176, 200, 216, 250, 288, and 300 to a box.

In the beginning of the Washington Navel orange work, rings of the corresponding sizes were used and the sizing was done by hand.

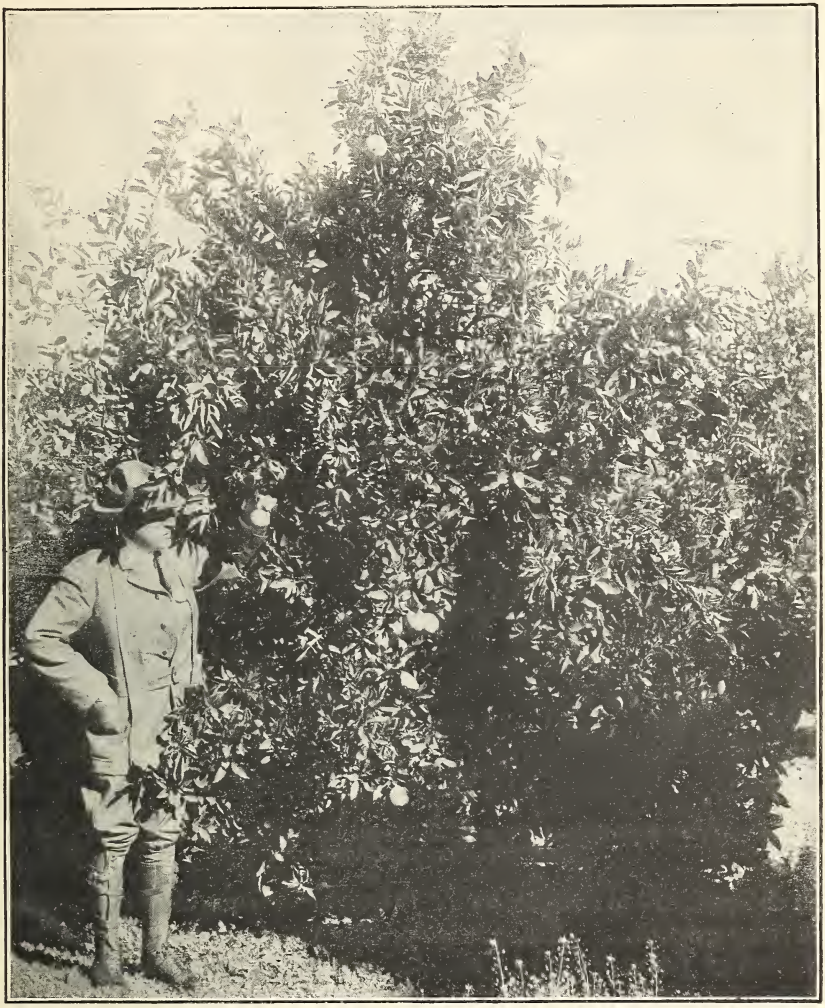

FIG. 4.—"Australian" type, a barren and worthless type of the Washington Navel orange.

This is a perfectly satisfactory method, but with the large number of trees studied the automatic grader is more efficient. In the case of pomelos or lemons the sizing must of necessity be done with rings, as there is at present no satisfactory automatic sizer available. The orange sizer is small and compact and easily moved about the grove

by two men. Figure 5 shows the mechanical sizer at work and illustrates the method used in grading the fruit from the select trees. The small platform scale for weighing the fruit, mounted on a truck, is also shown.

The fruits of each size of each grade are counted and weighed separately and the results noted in the regular blank form, except in the case of culls, where no sizes are made and the weight is taken as a whole. By adding the totals of the three grades the total product of the tree is obtained. These data, including the number and weight of fruits of each grade and size from each tree, form a definite basis for scoring a tree as to its performance and make possible an accurate

FIG. 5.—Portable mechanical orange sizer and scales for weighing the different lots of grades and sizes of fruit from individual trees.

and comprehensive comparison of the value of individual trees under the same conditions. When, as is usually the case, the growers keep a record of the product of each size and grade from the grove as a whole, these data are of further comparative value. While oranges are frequently divided into additional grades commercially, for bud-selection purposes the three grades mentioned above are sufficient to give reliable data as to the quality of the fruit, and the personal equation in sorting into extra fancy and other grades of fine-drawn distinction is thus eliminated. Moreover, the quantity of sound, free-from-blemish, marketable fruit of good quality that the tree produces is the most important factor to be considered in this work. This

matter, however, may vary under different conditions and can be adjusted to meet the prevailing methods of grading and sizing practiced in the locality where performance records are to be made.

COUNTING AND WEIGHING.

It was found most convenient systematically to pick up five oranges at one time in the case of the smaller sizes, three in the right hand and two in the left, in order to make an accurate count. In the case of the large sizes a definite number is taken up, the same each time, in order to avoid mistakes in the count. This may seem to be a very simple matter, but errors are very easily made, especially after long-continued work, and it is probable that most workers along this line should practice checking up results in order to become absolutely accurate before attempting to count the fruit from select trees.

A small platform balance scale weighing from 1 ounce to 250 pounds is used to obtain the weights of fruits. The weigher is frequently balanced to avoid mistakes in weighing, and great care is taken to secure exact weights of each lot of fruit. The balance is mounted on a small hand truck for convenience in moving about the grove. (See fig. 5.)

RECORD BLANKS.

The following outline illustrates the method used in this work of recording data on the performance records of individual trees. A separate sheet is necessary for each tree.

Orange performance record.

Date..... Series .....
Location..... Grower..... Grove .....
Variety..... Picker..... No. of tree.....

Designation of sizes.	Number of fruits.				Weight of fruit.			
	Orchard.	Standard.	Culls.	Total.	Orchard.	Standard.	Culls.	Total.
300								
288								
250								
216								
200								
176								
150								
126								
112								
96								
80								
Total								

Description of tree.....

Remarks.....

In order to bring these data together so that the records of different years may be easily compared, the following form for showing the total data from each tree for a period of five years is suggested:

Orange pedigree record.

Dates ..... Series .....
Location ..... Grower ..... Grove .....
Variety ..... Picker ..... No. of tree .....

Grades and sizes.	Number.					Weight.				
	Date.	Date.	Date.	Date.	Date.	Date.	Date.	Date.	Date.	Date.
Grades:										
Orchard										
Standard										
Culls										
Total										
Sizes:										
300										
288										
250										
216										
200										
176										
150										
126										
112										
96										
80										
Total										

Description of tree .....

The arrangement of the record blanks used for pomelo and lemon data is based on the same principle as the orange record blanks and depends on the prevailing commercial practice of grading and sizing these fruits. These data are obtained in the grove, but where the fruit is held for curing or other purposes additional notes on the condition of the stored fruit can be taken when desired.

ARRANGEMENT OF DATA AND PHOTOGRAPHS.

The arrangement of data sheets and photographs can be made of great assistance in interpreting the results. The writer uses sheets of paper for the data and photographic prints of convenient size and arranged to fit loose-leaf ledger covers. In this way the sheets may be moved and grouped into any classification desired. It is desirable in the case of the pedigree records to arrange the leaves so that when the book is opened the photographs on one page face the data on the other page. Convenient arrangements will suggest themselves to those interested in studying the question of filing these records.

NOTE TAKING.

Detailed descriptions or notes of trees or fruits have not been extensively made. Such general notes are usually somewhat vague and unsatisfactory as a means of preserving definite ideas of the objects described. There are, however, certain notes that are very valuable, for example, the history of the trees; a description of the past and present methods of orchard management, particularly methods of soil treatment; the history of the cultivation of the grove; the kinds and quantities of fertilizers used or other sources of soil improvement; the methods and system of irrigation; the methods of pruning, if any; and any other facts bearing on the maintenance of the grove. One objection to the taking of extensive notes in this type of work is that the time and energy devoted to this phase are likely to defeat the principal object of the work. The most eminently successful plant breeders with whom the writer has been acquainted have used but few notes, preferring to have the plants themselves as notes and to devote their attention to a first-hand study of the plants. There is, perhaps, a happy medium, which must be discovered by each worker for himself, which will permit of the study of a sufficiently large number of plants and the preservation of all necessary data.

CITRUS-IMPROVEMENT CLUBS.

The writer suggests the organization of citrus-improvement clubs in the various citrus-growing localities for mutual assistance in the study of this subject. Such clubs, with a membership consisting of interested citrus growers, could hold regular meetings for the purpose of discussing individual results and the criticism of methods of work. It would be possible for such clubs to maintain a set of record books in which a copy of each member's data could be kept, similar to the plan of certain live-stock breeders' associations. The membership in such organizations should be undertaken only by growers who are willing to devote the necessary time, care, and thought to their work, so that the results will be reliable and of permanent value. It would be possible for the local clubs to have a central organization through which annual or other meetings might be held for the purpose of bringing together interesting information from the different clubs. Some such active cooperation would be of great value in promoting a widespread and general interest in this work.

IMPORTANCE OF UNIFORMLY PRODUCTIVE TREES.

The great difference between the yield of the best trees in a grove and the average yield per tree of that grove, found so far in every grove of Washington Navel oranges and Marsh pomelos, indicates that

in the established groves there is a great lack of uniformity in fruit production. For instance, in the case of one orange grove the best tree produced 432 pounds of fruit, while the average of the grove was about 175 pounds. Similar proportions were observed in all other groves studied. The differences in the yield of the best and average pomelo trees were even greater than in the case of the orange trees. Conservative growers have frequently estimated that uniform trees like the best ones in their groves would more than double their crops. The yield test for individual trees, like the Babcock test for dairy cattle, should discover the "boarders," or worthless trees, that cost just as much to maintain as the productive, profitable ones. There is a certain definite investment in every tree in the grove which can easily be figured out by the grower, and the loss or profit of the trees can be determined by means of the yield test and the selling price of the fruit. Such information must be of intense interest to every fruit grower and can be secured at little expense of time or money.

THE VALUE OF RELIABLE SELECT TREES.

To every prospective planter of citrus trees the reliability and character of trees planted are of paramount importance. The expense for buds is a comparatively small item in the planting of a grove, not in any sense commensurate with their importance to the planter. It is probable that the additional expense necessary for the production of selected stock will be gladly borne by the planter provided he is assured of its improved value. Performance records from trees which are extra heavily fertilized or favored in any way might prove misleading. Therefore it will be necessary to avoid the error of depending on records that have been secured under unfair conditions. Too much emphasis can not be laid on this point, as dishonest and unscrupulous nurserymen might mislead purchasers of their stock in order to reap a temporary, dishonest reward. The reputation of the grower of select buds of trees must be taken into account as well as the performance records of his breeding stock.

SUMMARY.

The object of these investigations is the demonstration of methods for the elimination of unprofitable trees in citrus groves and the production of reliable select citrus trees for new plantings.

These investigations, begun in April, 1909, are being carried on with Washington Navel oranges and Marsh pomelos near Riverside, Cal. If desirable, this work will be extended to other sections of the citrus belt and to deciduous and other fruits as soon as men are provided to conduct the work.

A series of consecutive performance records is necessary to secure reliable select stock, and methods of securing these data and tabulating them for intelligent interpretation are described in the foregoing pages.

The yield of established orange and pomelo trees of the same variety varied greatly in the same grove and under similar conditions during the past season. Further data are necessary in order to know whether the high and low yielders of the past season are consistent in their behavior.

The importance of uniformly high-yielding trees bearing a large proportion of valuable fruit is apparent by comparing the yield of the best with that of the poorest trees in any grove. It is probable that the yield can be greatly increased and improved by securing trees of uniformly good performance.

The development of reliable select stock is of the greatest possible importance to the prospective planter.

Approved:

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *March 21, 1911.*

[Cir. 77.]

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